RESULTS OF MEASURES

MADE AT THE

ROYAL OBSERVATORY, GREENWICH

UNDER THE DIRECTION OF

SIR FRANK DYSON, M.A., LL.D., F.R.S.,
ASTRONOMER ROYAL,

OF

PHOTOGRAPHS OF THE SUN

TAKEN

AT GREENWICH, AT THE CAPE, AND IN INDIA

IN THE YEAR

1916.

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GREENWICH PHOTO-HELIOGRAPHIC RESULTS, 1915.

LEDGERS—PAGE D 133, COL. 14, LINE 10, *for* 117 *read* 217.

GREENWICH PHOTO-HELIOGRAPHIC RESULTS, 1916.

INTRODUCTION.

§ 1. *Measures of Positions and Areas of Sun Spots and Faculæ in* 1916.

The photographs from which these measures were made were taken at the Royal Observatories of Greenwich or of the Cape; at the Kodaikánal Observatory, Southern India, or at Dehra Dûn, North-West Provinces, India.

The photographs of the Sun, obtained at Greenwich, were taken with the Dallmeyer Photoheliograph, of 4 inches aperture, usually stopped down to 2·9 inches. The instrument was used in the Transit of Venus expedition to New Zealand in 1874, and, as now adapted, gives a solar image of about 10-centimetre radius on the photographic plate.

The photographs have been taken throughout the year on gelatine dry plates, "Process" or "Lantern," supplied by the Imperial Dry Plate Company, being used with hydroquinone development.

The photographs from the Cape Observatory were taken under the superintendence of Mr S. S. Hough, His Majesty's Astronomer at the Cape, and those from Kodaikánal under the superintendence of Mr John Evershed, Director of that Observatory. The photographs from Dehra Dûn, which have been forwarded by the Solar Physics Committee to fill the gaps in the combined series, were taken under the superintendence of the Deputy Surveyor-General, Trigonometrical Survey of India. At three of the observatories the instrument employed was a Dallmeyer Photoheliograph giving an image of the Sun about 10 centimetres in radius; at Kodaikánal a Cooke photo-visual object-glass of 6 inches aperture was used, the image of the Sun being on about the same 10-centimetre scale. The plates and development used have been much the same at each of the four collaborating observatories.

Photographs of the Sun were available for measurement upon each day in 1916 except June 19, those finally selected for measurement being supplied by the different observatories as under :—

Greenwich	180
Cape	166
*Kodaikánal	1
Dehra Dûn	18
Total	365

The following are the signatures of those persons who measured the photographs for the year 1916 :—

E. W. Maunder	M	Annie S. D. Maunder	AM
H. W. Newton	N	H. Lyne	HL

At the principal focus of the photoheliographs excepting that at Kodaikánal two spider-lines are fixed by which the zero of position-angles on the photographs can be determined. These lines are respectively perpendicular and parallel to the equator in the photoheliographs at the Cape and at Dehra Dûn, but are inclined to it at an angle of about 45° in that at Greenwich.

The zero of position-angles for the Greenwich and Cape Photoheliographs has been determined by the measurement of a plate which has been exposed twice, with an interval of about 100 seconds between the two exposures, the instrument being firmly clamped. Two images of the Sun, overlapping each other by about a fifth part of the Sun's diameter, were therefore produced upon the plate, and the exposures having been so given that the line joining the cusps passed approximately through the centre of the plate, the inclination of the wires of the photoheliograph to this line was measured with the position-micrometer, and a small correction for the inclination of the Sun's path was then applied. The following tables give the correction for zero of position for the mean of the two wires as thus determined.

The zero-correction used throughout the year 1916 in the reduction of the photographs taken at Greenwich was +2°·8.

The zero-corrections used in the reduction of the photographs taken at the Cape Observatory were as follows :—

Jan. 1 to April 30, +0°·1 ; May 1 to Nov. 13, +0°·2 ; Nov. 13 to Dec. 31, +0°·1.

The orientation of the photograph taken at Srinagar with the Kodaikánal Photoheliograph was determined by the photographed image of a plumb line.

* This photograph was taken during an expedition to Srinagar in Kashmir.

DALLMEYER PHOTOHELIOGRAPH, GREENWICH.

Date. Greenwich Civil Time.			Correction for Zero.	Date. Greenwich Civil Time.			Correction for Zero.
		d h	° ′			d h	° ′
1915	December	28. 11	+2 45	1916	July	26. 11	+3 04
1916	January	10. 12	+2 47		August	1. 11	+2 40
		23. 12½	+2 54			1. 11	+2 46
		29. 10	+2 54			26. 12	+2 51
	February	5. 11	+2 46		September	7. 10	+2 46
	April	1. 8½	+2 53			7. 10	+2 46
		1. 11	+2 52			22. 8½	+2 38
		1. 13	+2 54			23. 9	+2 48
		21. 8	+2 34		October	7. 11	+2 49
	May	10. 9	+2 43			7. 11	+2 48
		19. 12½	+2 51			21. 10	+2 36
		21. 7½	+2 42			21. 10	+2 43
		26. 8	+2 47		November	9. 10	+2 50
	June	6. 10	+2 51			9. 11	+2 49
		8. 8	+2 38			21. 11	+2 49
	July	4. 7½	+2 45			21. 11	+2 53
		5. 10½	+2 46		December	4. 12	+2 49
		5. 11	+2 39			30. 11	+3 03
		10. 14	+2 38			30. 11	+2 47
		20. 8	+2 36	1917	February	8. 12	+2 49

The wire frame was removed for cleaning on October 18.

DALLMEYER PHOTOHELIOGRAPH, CAPE OF GOOD HOPE.

Date. Greenwich Civil Time.			Correction for Zero.	Date. Greenwich Civil Time.			Correction for Zero.
		d h	° ′			d h	° ′
1915	December	6.	+0 4	1916	July	5. 8½	+0 10
1916	January	7. 12½	+0 6			21. 9	+0 13
		24. 10½	+0 3		August	4. 9	+0 24
	February	7. 9	−0 3			21. 12	+0 17
		7. 9½	+0 11		September	6. 8	+0 15
		23. 9½	+0 8			20. 10	+0 11
	March	6. 8	+0 7		October	5. 10	+0 21
		24. 9	+0 7			20. 8	+0 9
	April	5. 9	+0 8		November	6. 9	+0 1
		19. 12	+0 6			20. 8	+0 1
	May	9. 12	+0 19		December	5. 8	+0 4
		22. 9	+0 5			19. 8½	+0 5
	June	20. 12	+0 9			30. 8	+0 15
				1917	January	16. 8	−0 8

The wire frame was removed for the insertion of a new wire on December 30.

The adjustment of the wires in the Dehra Dûn Photoheliograph was usually tested by stopping the driving clock immediately after a photograph had been taken and making a second exposure some two minutes after the first, a portion of a second image of the Sun, just intersecting the first, being thus obtained upon the plate.

The zero-correction adopted during 1916 for the Dehra Dûn photographs was —0°·5.

The *first* column on each page contains the Greenwich civil time at which each photograph was taken, expressed by the day of the year and decimals of a day, reckoning from Greenwich mean midnight January 1d. 0h., and also by the day of the month (civil reckoning), the latter being placed opposite the total area of Spots and Faculæ for the day. The photographs taken at Greenwich, at the Cape, and in India at Kodaikánal and Dehra Dûn are distinguished by the letters, G, C, K, and D respectively.

The *second* column contains the initials of the two persons measuring the photograph; the initial on the left being that of the person who measured the photograph on the left of the centre of the measuring instrument, and that on the right being that of the person who measured on the right of the centre.

The *third* column gives the No. of the group which is numbered in order of its appearance. Groups only seen once are distinguished by the number of the Rotation in which they occur, and a letter which represents the order of their appearance in that Rotation.

The Rotations correspond to the synodic rotation of the Sun, and the commencement of each is defined by the coincidence of the assumed prime meridian with the central meridian, the assumed prime meridian being that meridian which passed through the ascending node at mean noon on January 1, 1854, and the assumed period of the Sun's sidereal rotation being 25·38 days. The numeration of the rotations is in continuation of Carrington's series (*Observations of Solar Spots made at Redhill* by R. C. Carrington, F.R.S.), No. 1 being the rotation commencing 1853 November 9.

The *next two* columns give the distance from the centre of the Sun in terms of the Sun's radius, and the position-angle from the Sun's axis, reckoned from the Sun's north pole in the direction n, f, s, p, both results being corrected for the effects of astronomical refraction.

The measures of the photographs were made with a large position-micrometer specially constructed by Messrs Troughton and Simms for the measurement of photographs of the Sun up to 12 inches in diameter. In this micrometer the photograph is held with its film-side uppermost on three pillars fixed on a circular plate, which can be turned through a small angle, about a pivot in its circumference, by means of a screw and antagonistic spring acting at the opposite extremity of the diameter. The pivot of this plate is mounted on the circumference of another circular plate, which can be turned by screw-action about a pivot in its circumference, 90° distant from that of the upper plate, this pivot being mounted on a circular plate with a position-circle which rotates about its centre. By this means small movements in two directions at right angles to each other can be readily given, and the photograph can be accurately centred with respect to the position-circle. When this has been done, a positive eyepiece, having at its focus a glass diaphragm ruled with cross-lines into squares, with sides of one-hundredth of an inch (for measurement of areas), is moved along a slide diametrically across the photograph, the diaphragm being nearly in contact with the photographic film, so that parallax is avoided. The distance of a spot or facula from the centre of the Sun is read off by means of a scale and vernier to 1-250th of an inch (corresponding to 0·001 of the Sun's radius for photographs having a solar diameter of 8 inches). The position-angle is read off on the large position-circle which rotates with the photographic plate. The photograph is illuminated by diffused light reflected from white paper placed at an angle of 45° between the photograph and the plate below.

The following is the process of measurement of a photograph :—By means of the screws attached to the circular plates carrying the pillars which hold the photograph, the image of the Sun is centred as accurately as possible by rotation. The position-circle is then set to the readings 0°, 90°, 180°, and 270° in succession, and the scale readings taken for the two limbs. The scale being so adjusted that its zero coincides with the centre of rotation of the position-circle, the mean of the eight readings for the limb gives the mean radius of the Sun directly.

The zero of the position-circle of the micrometer has been determined from the readings of the position-circle for the four extremities of the two wires. The resulting correction is applied with the zero correction of the photoheliograph to all position-circle readings for spots and faculæ.

The uncorrected distance from the Sun's centre for spots and faculæ is read off directly to 1-250th of an inch by means of a scale and vernier, the zero of the scale of the micrometer being adjusted to coincide with the centre of the instrument.

All photographs are measured independently by two persons, and the means taken.

In the case of large or complex groups of spots, the positions of the chief components are measured individually, and also for groups so near the east or west limbs of the Sun that the effects of foreshortening are appreciable. In other cases the position of the centre of a group is estimated in the micrometer. In this respect a difference has been made in the practice of previous years, where in this section components of groups are given separately and combined into groups in the Ledgers. It is found that the present method saves much numerical work without any diminution of accuracy.

When required, corrections are applied to the measured distances and position-angles for differential refraction. The formula is given in the *Introduction* for 1909. It is seldom necessary, however, to apply this correction except to a few photographs taken at Greenwich in mid-winter.

The distance from centre in terms of the Sun's radius given in the *fourth* column is found by dividing the measured distance r, as corrected for refraction, by the measured mean radius of the Sun, R; and the position-angle from the Sun's axis given in the *fifth* column is obtained by applying to the position-angle (from the N. point) corrected for refraction the position-angle of the Sun's axis.

The *sixth* and *seventh* columns give the heliographic longitude and latitude of the spot.* If r be the measured distance of a spot from the centre of the Sun's apparent disc, R the measured radius of the Sun on the photograph, (R) the tabular semidiameter of the Sun in arc, and ρ, ρ' the angular distances of a spot from the centre of the apparent disc as viewed from the Sun's centre and from the Earth respectively, ρ is obtained from the equations:—

$$\rho' = \frac{r}{R}(R); \text{ and } \sin(\rho + \rho') = \frac{r}{R}.$$

If D and λ are the heliographic latitudes of the Earth and the spot respectively, referred to the Sun's equator, and l the heliographic longitude of the spot from the solar meridian passing through the centre of the disc, longitudes west of the centre being reckoned as positive, and χ the position-angle from the Sun's axis,

$$\sin\lambda = \cos\rho \sin D + \sin\rho \cos D \cos\chi$$
$$\sin l = -\sin\chi \sin\rho \sec\lambda.$$

* "Researches on Solar Physics: Heliographical Positions and Areas of Sun Spots observed with the Kew Photoheliograph during the years 1862 and 1863," by W. De La Rue, B. Stewart, and B. Loewy. *Phil. Trans.*, 1869.

The position-angle χ is found from the position-angle from the North Point by subtracting P, the position-angle of the N end of the Sun's axis, measured eastward from the North Point of the disc. The heliographic longitude of the spot is $l+L$, where L is the heliographic longitude of the centre of the disc. The three quantities P, D, and L for the time of the exposure of each photograph are derived from the Ephemeris for Physical Observations of the Sun given on p. 551 of the *Nautical Almanac* for 1916, and are printed (in brackets) in the *fifth*, *sixth*, and *seventh* columns respectively. D, the heliographic latitude of the Earth, is of course the same as the latitude of the centre of the Sun's disc.

The inclination of the Sun's axis to the ecliptic is assumed to be 82° 45′, the longitude of the ascending node for 1916·0 to be 74° 35′·3, and the period of the Sun's sidereal rotation to be 25·38 days; the meridian which passed through the ascending node 1854 January 1, Greenwich Mean Noon, being taken as the zero meridian.

The measures of areas given in the *last three* columns were made with a glass diaphragm ruled into squares, with sides of one-hundredth of an inch, and placed as nearly as possible in contact with the photographic film. The integral number of squares and parts of a square contained in the area of a spot or facula was estimated by the observer, two independent sets of measures being made by two observers. The mean of the two sets of measures has been taken for each photograph. The area of the spot or facula in millionths of the Sun's visible hemisphere is derived from the measured area by correcting for foreshortening.

§ 2. *General Catalogue of Groups of Sun Spots for* 1916.

This Catalogue is compiled from a general ledger in which the daily results for each group are collected together. The Catalogue contains every group of spots which lasted for two or more days, and the group numbers are in continuation of those given in 1915 and previous years. Groups seen only once are not included, but appear in the Daily Results with a distinctive numeration. The areas and positions of each group, given in the *seventh* to *eleventh* columns, are the mean areas of umbræ and whole spots, and the mean longitude and latitude for the period of observation of the groups. References are given in the *twelfth* column to such groups as are given in detail in the Ledgers.

§ 3. *Ledgers of the Areas and Heliographic Positions of the Principal Groups of Sun Spots for* 1916.

Ledger I.—Recurrent Groups.—This Ledger supersedes the Catalogue of Recurrent Groups of Sun Spots given in previous years of the *Greenwich Photo-Heliographic Results*, and the reference numbers of the series are in continuation of

those given therein. The groups forming this Ledger have been abstracted from a general Ledger of all spot groups seen throughout the year, and were selected upon the following plan, reference being made to the *General Catalogue*:—If any spot group when first seen was 60° or more to the east of the Central Meridian—the detail given in the *fourth* column—then the Catalogue, and, if necessary, the Daily Results also, were searched some fifteen or sixteen days earlier, to ascertain whether a spot group of similar heliographic longitude and latitude was then near the west limb of the Sun. Similarly, if any spot group when last seen was 60° or more to the west of the Central Meridian—the detail given in the *sixth* column—then the Catalogue and, if necessary, the Daily Results also, were searched some fifteen or sixteen days later, to ascertain whether a spot group of similar heliographic longitude and latitude was then near the east limb of the Sun. Both the search forward and the search backward have been made in the case of every spot group that was observed close to both the east and west limbs, in order that no possible case of identity might be overlooked. When there appeared to be a case of probable identity between spot groups observed in two consecutive rotations of the Sun, the character of the second group has been carefully compared with that of the first in each of the three elements—area, longitude, and latitude. In cases where the evidence appeared to render probable the continued existence of the spot, it has been numbered in the Ledger, and where there has been some uncertainty a note has been added. If, on the other hand, the evidence appeared to go in the other direction, but was not quite decisive, the series has been printed in the Ledger but a separate number has not been given it. It has been distinguished by the number of the preceding series, placed in brackets and marked with an asterisk. In cases where a well-defined series has been recorded, there have sometimes been included in brackets spot groups undoubtedly belonging to the same general disturbance, but for which the evidence of continuity was not sufficient.

Besides the Ledgers of the groups, there have been printed in a similar manner important components of the principal groups. This has been done in all cases where it appeared probable that an individual component lasted to the second or third rotation after its first appearance.

Ledger II.—Groups seen only in one Apparition.—This Ledger contains the most important of those groups which do not last to a second rotation. Individual components are also given after their respective groups, where they are large and distinctive.

Note.—The general plan of results contained in Ledgers I. and II. is the same as that of the Ledger printed in previous volumes of the *Greenwich Photo-Heliographic Results*; the respective columns correspond in all respects.

§ 4. *Total Areas of Sun Spots and Faculæ for each day, and Mean Areas and Mean Heliographic Latitude of Sun Spots and Faculæ for each Rotation of the Sun, and for the year* 1916.

This section requires no further explanation.

In the course of examination of a number of photographs taken in March 1916, several small faint markings were detected in high southern latitude which for distinction were called "flecks." They are much less definite than spots, but their existence was verified in each case on two photographs. They are discussed in detail in a paper by Mrs Walter Maunder in *M.N.R.A.S.*, June 1917. They have not been included in the general body of the observations of sun spots, but are given in the following table :—

SUN "FLECKS" IN HIGH SOUTHERN LATITUDES, 1916 MARCH.

Date.	Where taken.	G.M.T. of 1st Photograph.	Heliographic		G.M.T. of 2nd Photograph.	Heliographic	
			Long.	Lat.		Long.	Lat.
		h m s	°	°	h m s	°	°
March 8	G	11 59 20	143·2	−72·2	12 2 14	143·7	−72·2
9	C	7 50 42	136·4	−72·2	7 51 32	136·7	−72·4
10	C	8 10 28	120·2	−73·3	8 11 28	120·8	−73·3
11	C	8 19 47	..	..	8 20 47	..	..
12	G	12 18 5	134·4	−71·1	12 28 10	134·4	−71·3
13	C	7 20 42	135·3	−71·1	7 21 43	135·6	−69·9
14	C	7 56 7	118·3	−74·6	7 57 7	119·3	−74·6
March 9	C	7 50 42	137·3	−62·5	7 51 32	136·9	−62·6
10	C	8 10 28	125·6	−63·1	8 11 28	125·6	−63·0
11	C	8 19 47	126·8	−62·3	8 20 47	126·5	−62·5
12	C	10 55 1	130·5	−63·8	10 57 53	131·2	−63·6
12	G	12 18 5	130·5	−63·4	12 28 10	130·3	−63·0
13	C	7 20 42	123·0	−63·5	7 21 43	122·3	−63·1
14	C	7 56 7	119·9	−63·5	7 57 7	120·0	−63·3
March 13	C	7 20 42	138·6	−65·4	7 21 43	137·7	−65·1
14	C	7 56 7	133·3	−65·9	7 57 7	133·0	−66·6
March 13	C	7 20 42	124·3	−64·8	7 21 43	124·6	−64·7
14	C	7 56 7	108·3	−64·4	7 57 7	107·9	−64·0

F. W. DYSON.

Royal Observatory, Greenwich,
1921 *April* 25.

ROYAL OBSERVATORY, GREENWICH.

MEASURES OF POSITIONS AND AREAS

OF

SUN SPOTS AND FACULÆ

ON

PHOTOGRAPHS

TAKEN WITH THE

PHOTOHELIOGRAPHS

AT GREENWICH, AT THE CAPE, AND IN INDIA,

WITH THE DEDUCED

HELIOGRAPHIC LONGITUDES AND LATITUDES.

1916.

MEASURES of POSITIONS and AREAS of SUN SPOTS and FACULÆ on PHOTOGRAPHS taken at the ROYAL OBSERVATORIES of GREENWICH and of the CAPE, and in INDIA, at KODAIKÁNAL, at DEHRA DÛN, and at SRINAGAR, in the Year 1916.

NOTE.—The Greenwich Civil Time at which the Photograph was taken is expressed by the Day of the Year and decimals of a day, reckoning from Midnight, January 1^{d} 0^{h}.

For convenience of reference, the Month and Day of the Month (Civil Reckoning) are added.

The letter G. signifies that the photograph was taken at Greenwich; the letters C., K., D., or S., that it was taken at the Cape, Kodaikánal, Dehra Dûn, or Srinagar respectively; the time given is Greenwich Civil Time.

The position-angles are reckoned from the North Pole of the Sun's Axis in the direction N., E., S., W., N.

The Groups of Spots are numbered in the order of their appearance, and in continuation of the Group-numbers given in previous years, except in the case of Groups seen only on one day, which are distinguished by the number of the Rotation during which they were observed, and by a letter given in the order of their appearance. When there is no number in the third column, it is to be understood that there is a Facula unaccompanied by a Spot. The positions of Faculæ relative to the Spots with which they are associated are indicated by the letters *n, s, p, f, c*, denoting respectively north, south, preceding, following, concentric.

The Areas of Spots and Faculæ are corrected for Foreshortening, and are expressed in millionths of the Sun's visible Hemisphere.

In the line immediately below the results for each day are given in brackets :—1. The Position Angle of the Sun's Axis (from the North point); 2. The Heliographic Longitude and Latitude of the Centre of the Disc; 3. The total areas for each day of Spots and Faculæ.

Greenwich Civil Time.	Measurers.	No. of Group. (No. of Rotation and *Letter* for Groups only seen once.)	Distance from Centre in terms of Sun's Radius.	Position Angle from Sun's Axis.	Heliographic Longitude.	Heliographic Latitude.	Spots. Area of UMBRA for each Spot or Spot Group (and for Day).	Spots. Area of WHOLE for each Spot or Spot Group (and for Day).	Faculæ. Area for each Group (and for Day).
1916.				°	°	°			
0·444	N, AM		0·932	259·4	22·9	−11·0			79
			0·919	240·0	19·1	−28·7			126
			0·908	311·1	10·6	+34·9			63
			0·838	246·8	9·6	−21·1			67
			0·824	229·6	3·4	−34·3			180
		7575	0·984	249·8	34·0	−20·4	0	55	298*f*
		833e	0·486	224·4	335·8	−23·1	0	6	
		7591	0·423	5·1	311·9	+21·7	7	13	
C.		7581	0·274	153·0	306·8	−17·1	35	242	
		833f	0·185	126·8	305·6	− 9·4	0	5	
		7584	0·534	56·6	286·9	+14·2	72	449	
		7586	0·522	70·0	284·7	+ 7·6	19	58	
		7588	0·771	124·9	268·5	−28·3	2	6	213*c*
			0·867	59·2	259·5	+24·5			95
			0·840	111·6	258·3	−19·8			97
			0·932	108·0	245·8	−17·9			215
			0·969	60·0	242·5	+28·0			199
Jan. 1				(+2·4)	(314·2)	(−3·1)	(135)	(834)	(1632)
1·423	N, AM		0·966	248·3	13·2	−19·4			141
			0·910	237·0	4·1	−31·1			350
			0·926	311·3	0·4	+36·0			131
			0·877	226·2	355·9	−39·2			81
		7591	0·460	337·2	312·3	+21·8	0	8	
C.		7581	0·261	201·1	306·9	−17·2	43	228	
		833g	0·166	185·9	302·3	−12·7	0	3	
		7586	0·317	51·6	286·8	+ 8·2	11	48	
		7584	0·398	39·3	286·3	+14·8	51	325	
		7592	0·874	108·4	241·1	−17·6	23	86	262*c*
			0·769	55·7	257·7	+23·3			78
1916.				°	°	°			
1·423	N, AM		0·924	57·1	239·4	+28·6			129
C.			0·979	52·3	228·7	+35·8			139
Jan. 2				(+1·9)	(301·3)	(−3·2)	(128)	(698)	(1311)
2·367	N, AM		0·945	235·8	357·9	−33·3			261
			0·957	307·3	355·5	+34·1			151
			0·930	226·2	352·3	−41·4			100
			0·871	297·5	345·1	+21·9			154
		7591	0·577	315·3	314·6	+21·1	20	92	
		7581	0·385	230·8	307·0	−17·1	31	179	
		7586	0·197	11·0	286·7	+ 7·8	7	33	
C.		7584	0·314	6·7	286·7	+14·8	38	237	
		7592	0·737	110·2	242·8	−17·0	35	155	168*c*
			0·848	52·1	239·0	+29·2			267
			0·939	49·3	227·2	+36·2			174
			0·895	117·6	227·1	−26·1			145
			0·971	62·1	216·4	+26·1			109
Jan. 3				(+1·5)	(288·9)	(−3·3)	(131)	(696)	(1529)
3·451	N, AM		0·971	235·4	349·7	−34·3			66
			0·912	246·7	339·5	−22·6			64
		7593	0·893	288·4	335·5	+14·7	4	28	85*c*
		7591	0·719	302·8	314·6	+20·3	29	179	146*c*
		7581	0·572	244·2	307·1	−17·3	45	192	
C.		7586	0·312	311·0	288·3	+ 8·5	8	36	
		7584	0·380	328·4	286·5	+15·5	36	234	
		7592	0·565	118·4	243·1	−18·4	33	182	
		7594	0·982	103·7	195·3	−14·1	18	215	353*c*
			0·936	168·9	243·8	−69·4			69
			0·781	43·4	235·5	+31·9			46

Group 7575, 1915 December 25–1916 January 1. A sparse unstable stream forming in the rear of Group 7573, and generally arranged in two loose clusters, of which the following has greatly diminished by December 31. Group 7581, 1915 December 26–1916 January 8. A large regular spot followed by an irregular train of small spots. Group 7584, 1915 December 29–1916 January 8. A few very small spots on December 29, rapidly developing into a fine straight stream of which the first and last members are large regular spots. The group declines rapidly after January 1. Group 7586, 1915 December 30–1916 January 7. A few small unstable spots in an irregular stream, *s* Group 7584, the leader being a small regular spot. Group 7588, 1915 December 30–1916 January 1. A small faint spot *f* Group 7587. Group 7591, 1916 January 1–7. A very irregular stream in continual change. A large composite spot has formed at the head of the group by January 5, but has passed out of sight at the West limb by January 7. Group 7592, January 2–12. Four small spots appearing suddenly on January 2 and developing during the succeeding days into a long, broad, and irregular stream of spots, mostly small and unstable, and grouped into three clusters. The leader of the group is the only fully developed and stable spot, and remains alone after January 9. Group 7593, January 4–5. A few small spots in a short irregular stream forming suddenly *sp* Group 7591. Group 7594, January 4–16. A large regular spot, usually with